

# PATENT ABSTRACTS OF JAPAN

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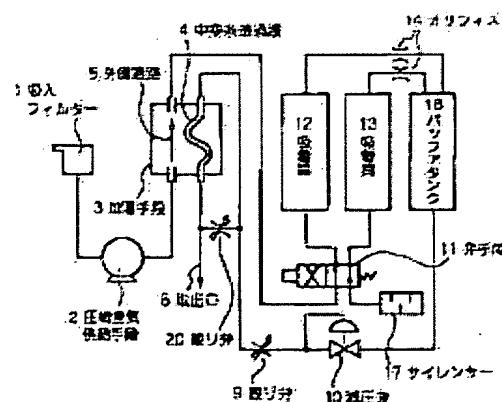
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## (54) OXYGEN CONCENTRATOR FOR MEDICAL PURPOSE

### (57)Abstract:

PURPOSE: To make it, possible to obtain an adequate humidification effect even in a season when an outside air temp. is low and relative humidity is low by eliminating the need for replenishing and exchanging water and cleaning a vessel and eliminating the leakage of gaseous oxygen and the producing sounds of air bubbles.

CONSTITUTION: A membrane module having moisture permeable hollow fiber membranes as diaphragms is installed as a humidifying means 3 to an oxygen concentrator by a pressure fluctuation adsorption method (PSA method). The oxygen concentrator is so constituted that the compressed air or the waste gases discharged by desorption at the time of a reduced pressure desorption stage of adsorption cylinders are supplied to the membrane module and that the moisture contained therein is separated away by the hollow fiber membranes. This moisture is applied to the oxygen enriched gases concentrated by the adsorption cylinders 12, 13 to humidify these gases. The humidifying means is housed together with an electric motor which attains a temp. higher than the ambient temp. at time of operation, a compressed air supplying means 2, a heat generating source, such as fan means and apparatus to be noise sources, into a casing having a soundproof function.



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## CLAIMS

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[Claim(s)]

[Claim 1]A compressed air supply means driven under power of an electric motor for supplying compressed air to at least one adsorption column and this adsorption column which were filled up with adsorbent, In an oxygen enricher by a pressure fluctuation adsorption process (the PSA method) which comprised fundamentally a fan means for cooling this electric motor and/or a compressed air supply means, A membrane module which uses as barrier membrane a hollow filament transmission film in which a moisture penetration is possible is attached as a humidification means, Compressed air from said compressed air supply means or exhaust gas which desorbs at the time of a decompression desorption process of an adsorption column, and is discharged is supplied to one barrier membrane side of a membrane module, Separation removal of the moisture contained in this compressed air or exhaust gas is carried out with a hollow filament transmission film, Constitute so that moisture separated with a hollow filament transmission film may be given to oxygen enrichment gas which was condensed in said adsorption column and supplied to the another side side of this membrane module and may be humidified, and. An oxygen enricher of medical application accommodating a humidification means by this membrane module in a case which has a soundproof function with an equipment which generates noise at the time of operation of the aforementioned electric motor and/or a compressed air supply means, a fan means, etc.

[Claim 2]A compressed air supply means driven under power of an electric motor for supplying compressed air to at least one adsorption column and this adsorption column which were filled up with adsorbent, In an oxygen enricher by a pressure fluctuation adsorption process (the PSA method) which comprised fundamentally a fan means for cooling this electric motor and/or a compressed air supply means, A membrane module which uses as barrier membrane a hollow filament transmission film in which a moisture penetration is possible is attached as a humidification means, Compressed air from said compressed air supply means or exhaust gas which desorbs at the time of a decompression desorption process of an adsorption column, and is discharged is supplied to one barrier membrane side of a membrane module, Separation removal of the moisture contained in this compressed air or exhaust gas is carried out with a hollow filament transmission film, Constitute so that moisture separated with a hollow filament transmission film may be given to oxygen enrichment gas which was condensed in said adsorption column and supplied to the another side side of this membrane module and may be humidified, and. An oxygen enricher of medical application constituting a passage through which compressed air from the aforementioned compressed air supply means, a humidification means by a membrane module, and a compressed air supply means to a humidification means passes so that beyond constant value may maintain at a high temperature from outdoor air temperature.

[Claim 3]An equipment which generates heat for a passage through which compressed air from a compressed air supply means, a humidification means by a membrane module, and a compressed air supply means to a humidification means passes at the time of operation of the aforementioned electric motor, a compressed air supply means, etc. is stored, The medical-application oxygen enricher according to claim 2 accommodating in a case in which temperature is raised from the open air.

[Claim 4]The medical-application oxygen enricher according to claim 3, wherein a case which stored an equipment which generates heat at the time of operation of an electric motor, a compressed air supply means, etc. is what has a soundproof function.

[Claim 5]Compressed air from a compressed air supply means is supplied to an outside passage of a hollow filament in a membrane module used as a humidification means, Make moisture contained in this compressed air penetrate to an inner passage of a hollow filament, and carry out separation removal, and supply compressed air which passed through inside of a membrane module to said adsorption column, and it is condensed, An oxygen enricher of the medical

application according to any one of claims 1 to 4 which is made to generate oxygen enrichment gas, supplies this oxygen enrichment gas to an inner passage of a hollow filament in a membrane module continuously, and is characterized by constituting so that moisture by which separation removal was carried out from compressed air may be given and humidified.

[Claim 6]A part of compressed air from a compressed air supply means is supplied to a passage of the outside of a hollow filament in a membrane module used as a humidification means, or the inside, Compressed air which made moisture contained in this compressed air penetrate to an other side passage of a hollow filament, carried out separation removal, and passed through inside of a membrane module, Make it emit in a case which has said soundproof function via a throttle valve, and on the other hand, supply the remainder of compressed air to said adsorption column, and it is condensed, An oxygen enricher of the medical application according to any one of claims 1 to 4 which is made to generate oxygen enrichment gas, supplies this oxygen enrichment gas to said other side passage of a hollow filament in a membrane module continuously, and is characterized by constituting so that moisture by which separation removal was carried out from compressed air may be given and humidified.

[Claim 7]Supply compressed air from a compressed air supply means to an adsorption column, condense it, generate oxygen enrichment gas, and exhaust gas which desorbs at the time of a decompression desorption process of this adsorption column, and is discharged is supplied to an outside passage of a hollow filament in a membrane module used as a humidification means, Exhaust gas which made moisture contained in this exhaust gas penetrate to an inner passage of a hollow filament, carried out separation removal, and passed through inside of a membrane module, Make it emit in a case which has said soundproof function via a throttle valve, and, on the other hand, the aforementioned oxygen enrichment gas is supplied to an inner passage of a hollow filament in a membrane module, The medical-application oxygen enricher according to any one of claims 1 to 4 constituting so that moisture by which separation removal was carried out may be given and humidified from exhaust gas.

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[Translation done.]

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#### DETAILED DESCRIPTION

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[Detailed Description of the Invention]

[0001]

[Industrial Application]In this invention, a respiratory failure patient (only henceforth a patient) is related with the oxygen enricher of the medical application used mainly for a home oxygen therapy.

Therefore, it is related with the humidification means of the new composition of the oxygen gas (it is [ the following containing oxygen enrichment gas ] the same) especially condensed by the pressure fluctuation adsorption process (henceforth the PSA method).

[0002]

[Description of the Prior Art]The aforementioned patient mainly uses the oxygen enricher of

medical application as a supply source of the oxygen gas used for a home oxygen therapy. For this reason, to an oxygen enricher, various conditions are required and the following matters are mentioned as those contents.

\*\* Since it is used for medical application, it is reliable.

\*\* since it is continuously used all day and night over a long period of time in many cases -- a patient, of course, the person himself/herself needs to be quiet equipment with little noise not to bar the good sleep including people of the family of living together or the same room.

\*\* Since nasal cavity membrane and a respiratory tract will get dry and the oxygen gas which carries out the regurgitation from the oxygen enricher by the PSA method will be accompanied by pain if a patient uses this as an object for breathing as it is, since it is the very much dry gas by which moisture was removed nearly thoroughly, have a function which humidifies this oxygen gas.

\*\* In order to use a power supply for home use, there is little power consumption.

[0003]About humidification of the oxygen gas of a \*\* \*\* clause, after in many cases making it pass through the inside of the container into which water went oxygen gas in the form of air bubbles and humidifying it, it is inhaling as an object for breathing. However, in order to humidify for a patient the oxygen gas which comes out from an oxygen enricher, much time and effort is taken, and since it is troublesome, there is a strong request of liking to be released from a supplement of water in a humidifier, exchange, the cleaning work of a container, etc.

[0004]The following problems are among the humidifiers currently mostly used from the former.

\*\* Since it is necessary to supply it and since the water in a humidifier carries out evaporation consumption as it is used, and saprophytic bacteria and algae breed or the dirt by adhesion of garbage etc. is in the container of this humidifier; about one cleaning is needed for one week in general.

\*\* the time of cleaning of a humidifier, or a supplement and exchange of water -- the lid of a humidifier -- enough -- and the fault of oxygen gas leaking and not going to patients unless it fastens certainly arises.

\*\* Since [ that the physical strength of the patient who uses an oxygen enricher and a humidifier is also comparatively weak and ] there are many elderly people, the lid of a humidifier may not become tight certainly enough and it is a matter serious [ this problem ] and serious.

[0005]\*\* Although this humidifier has what is protruded and attached to convex toward the exterior from the case which constitutes the coat of an oxygen enricher, and a thing which provides a concave hollow part in a case and is attached into this crevice, Some which are attached to convex [ former ] have an accident which collides accidentally and breaks the fitting part (many mainly serve as the feed hopper of oxygen gas) of a humidifier, when people walk near the equipment. It will be easy to accumulate garbage etc. and what is attached into the latter crevice will make a medical-application machine insanitary. For this reason, there is a method which garbage etc. make it hard to attach a door and to enter in front of a crevice, and a door is damaged or there is also a problem that it is troublesome at the time of a supplement of water or exchange.

[0006]\*\* In order for around-the-clock \*\* to use the oxygen enricher used for a home oxygen therapy, Among patients, those who are having good sleep barred because of this noise also have as a noise a sound produced from the air bubbles of the aforementioned humidifier which were not worried so much about an ear in at night when the circumference becomes \*\* in daytime with comparatively many surrounding back ground noises. For this reason, while accommodating a humidifier in the crevice of the case of an oxygen enricher, attaching a door to that front face and preventing invasion of garbage etc. like the above-mentioned, there are some which expected the reduction effect of this noise.

[0007]

[Problem to be solved by the invention]It aims at solving various problems produced with such a conventional humidifier, and not needing a supplement or exchange of water, and providing the oxygen enricher of the smaller quiet medical application of an operation sound.

[0008]

[Means for solving problem]Namely, the compressed air supply means driven under the power of

an electric motor for this invention to supply compressed air to at least one adsorption column and this adsorption column which were filled up with adsorbent, In the oxygen enricher by the pressure fluctuation adsorption process (the PSA method) which comprised fundamentally a fan means for cooling this electric motor and/or a compressed air supply means, The hollow filament transmission film in which a moisture penetration is possible is supplied to the membrane module used as barrier membrane, Constitute so that the moisture which carried out separation removal of the moisture contained in this compressed air with the hollow filament transmission film, and was separated from compressed air may be given to the oxygen enrichment gas which was condensed in said adsorption column and supplied to the humidification means and may be humidified, and. The humidification means by this membrane module is an oxygen enricher of the medical application accommodating in the case which has a soundproof function with the equipment which generates noise at the time of operation of the aforementioned electric motor and/or a compressed air supply means, a fan means, etc. The passage through which the compressed air from the aforementioned compressed air supply means, the humidification means by a membrane module, and a compressed air supply means to a humidification means passes, Maintenance of a temperature higher than outdoor air temperature is aimed at by accommodating each means in a case with the equipment which generates heat at the time of operation of the aforementioned electric motor, a compressed air supply means, etc. by 2nd being characterized by constituting so that beyond constant value may maintain at a high temperature from outdoor air temperature.

[0009]Hereafter, based on Drawings, this invention is explained in detail. Drawing 1 – drawing 3 are the flow plans of the oxygen enricher used as the suitable embodiment of this invention, and the figure (drawing of longitudinal section of a right half part) in which drawing 4 showed typically an example of the composition inside the external case of an oxygen enricher, and drawing 5 are the figures for explaining the composition inside the case (it accommodates in the left half part of an external case) which has a soundproof function.

[0010]An oxygen enricher by the PSA method comprises fundamentally the fan means 31 for cooling one piece filled up with the compressed air supply means 2 driven under power of an electric motor, and adsorbent or two or more adsorption columns 12 and 13 and an electric motor, and/or the compressed air supply means 2, and if needed to this. It has composition of having added the humidification means 3 for giving and humidifying moisture to the buffer tank 16 for storing oxygen enrichment gas emitted in the adsorption columns 12 and 13, and oxygen enrichment gas.

[0011]And air taken in from the suction filter 1 is supplied by turns to the two adsorption columns 12 and 13 by the valve means 11 which application-of-pressure compression is first carried out by the compressed air supply means 2, for example, controls operation of the PSA method when the number of adsorption columns is two. In an adsorption column, adsorption treatment of the nitrogen etc. is carried out, they generate oxygen gas (adsorption-under-elevated-pressure process), this oxygen enrichment gas is stored by the buffer tank 16, and that part lets the orifice 14 pass, End an adsorption-under-elevated-pressure process and an adsorption column under evacuation is made to flow backwards, desorption of nitrogen etc. which were adsorbed is helped, adsorbent is reproduced (decompression desorption process), and the exhaust gas is discharged in the atmosphere via the silencer 17. Oxygen enrichment gas stored by the buffer tank 16 is adjusted so that the reducing valve 10 and the throttle valve 9 may make a proper pressure and a flow, and it is supplied to a patient.

[0012]Although each of these pieces of equipment is stored in the external case 23, Since there is much noise at the time of operation, constitute a coat of the external case 23 from a sound insulating material, give insulation, and also as shown, for example in drawing 4. In order to reduce noise, it succeeds in various devices, such as forming the sound insulating board 33 in the atmospheric-streams ON passage 34 and the atmospheric exhaust passage 35 for cooling an electric motor and compressed air supply means 2 grade, or forming the duct 36 for silence in a pars basilaris ossis occipitalis of the external case 23.

[0013]And the compressed air supply means 2, the fan means 31, compressed air and exhaust gas that include an electric motor which serves as a source of release of noise at the time of

operation in order to improve a soundproof function further. The valve means 11 which controls flows, such as oxygen enrichment gas, is good to accommodate in the noise control case 29 and 30 which has a soundproof function in the external case 23 as shown in drawing 5, and to make it dual structure. Air taken in from the air intake 24, It goes into the noise control case 30 from the air inlet door 26 through the air air supply port 25 through the atmospheric-streams ON passage 34. Furthermore, it goes into the noise control case 29 from the connection opening 32 by the fan means 31. The part is incorporated into the compressed air supply means 2 as raw material air, and warm air warmed by most cooling a compressed air supply means including an electric motor and an exothermic equipment which consumes electrical energy in addition to this, and carrying out heat exchange is discharged in the atmosphere through the air outlet 28 and the duct 36 for silence from the airstream exit 27. However, although temperature inside a case becomes high to outdoor air temperature, properly, 30 \*\* or less of cooling methods are constituted so that it may become about 20 \*\*, and temperature which usually becomes higher than that outside air temperature also accommodates a humidification means by a membrane module in a case of this temperature. Although the two noise control cases 29 and 30 were combined and used, the fan means 31 may also be accommodated in an inside of a noise control case, and one noise control case may constitute it from an example of drawing 5.

[0014]The duct 36 for silence is what utilized effectively space between an external case, the ground, or a floor line which an axle-pin rake attached under the bottom of the external case 23 makes, and it comprises an insulator in contact with the bottom of the external case 23, and a sound-absorbing material is stuck on the atmospheric air passage inner surface, and a sound insulating board is also attached. Although a sound-absorbing material is stuck on both sides or one side of an insulator, a sound insulating board used by this invention is what ended two or more breakthroughs in the field, and it has the operation of letting cooling wind blows pass, absorbing a sound wave, it is not necessary to limit it to this, and it is needless to say that it may be a thing of other modes.

[0015]Since moisture was removed nearly thoroughly and oxygen enrichment gas which carries out decompression adjustment from the buffer tank 16, and is supplied to a patient will be dried, form humidifiers, such as a cellular formula which make it pass through a gas underwater and usually gives moisture after the reducing valve 10, but. Even a sound in which the air bubbles burst has been the target of low-noise-izing. Although the humidification means 3 which used a hollow filament transmission film is used instead of the conventional cellular type humidifier in this invention, noise is similarly accommodated in the high noise control case 29 of temperature from the open air for a Reason which is made smaller and which is sake [ a Reason ] and mentioned later.

[0016]The humidifier 3 using a membrane module which uses a hollow filament transmission film as barrier membrane used as The means for solving a technical problem in this invention is explained still in detail.

[0017]

[Function]The hollow filament transmission film which constitutes a membrane module penetrates the moisture in the atmosphere best, and the transmissivity is proportional to the partial pressure difference of the moisture in the atmosphere of the outside of a hollow filament transmission film, and the inside. When it is a primary side which separates a hollow filament transmission film wall and by which the application-of-pressure air containing moisture passes along the outside, and the downstream by which dry oxygen enrichment gas passes along the inside, a moisture partial pressure has a high primary side, and its downstream is low. When a moisture molecule carries out spreading diffusion of the inside of the membranous wall of a transmission film from a primary side and the principle of a moisture penetration diffuses it from a downstream wall surface, a moisture molecule penetrates a membranous wall. Since there is quite much moisture transmission quantity per unit area of the transmission film by a perfluoro ion-exchange membrane, a penetration [ at least ] efficient [ a primary side and a downstream partial pressure difference ] is obtained. In order to humidify the downstream to high.humidity, it is necessary to make the moisture partial pressure of a primary side high.

[0018]Since oxygen enrichment gas dry using the moisture contained in the atmosphere is

humidified, if the moisture partial pressure of the primary side of moisture supply is influenced by the moisture content contained in the atmosphere, i.e., the temperature and relative humidity of the open air, temperature is low and its relative humidity is low, it will also produce that the downstream cannot fully be humidified. As for the monthly average relative humidity for one year of the major cities from Hokkaido in Japan to Okinawa, most is distributed to 60 to 90%. And the season when humidity is low is in March and April, and the city relative humidity of little green Tokyo is low. The average monthly temperature which let one year pass is distributed over the wide range of -9~29 \*\*, winter, such as Hokkaido, is dried with indoor heating, and relative humidity becomes fairly low. The moisture partial pressure contained in 80% of atmosphere of relative humidity at 0 \*\* is 4.89 mb. If this is pressurized at 4 kgf/cm<sup>2</sup>G, capacity will be set to one fifth and a moisture partial pressure will be 24.45 mb, 5 times. In an experiment in the state where this temperature is low, it sometimes arose that the relative humidity of the oxygen enrichment gas which should be humidified does not reach the desired value by calculation with the moisture which penetrates and appears in the downstream. It was wholeheartedly cooled in the course until the application-of-pressure air of a primary side results in a humidification means as a result of research, since temperature became low, it dewed, and it turned out that the moisture partial pressure of sufficient gas required to humidify downstream gas may not be obtained.

[0019]Therefore, in order to maintain 24.45 mb of the primary side moisture partial pressure shown in this example, if it does not warm at not less than 22 \*\*, the moisture in the air dews, and it does not become more than the saturation water vapor pressure of that temperature. For this reason, if it not only pressurizes air, but temperature higher than the open air which adopts that temperature is not used in order to raise the moisture partial pressure of a primary side, a high moisture partial pressure is unmaintainable. The temperature and the target humidification value of downstream gas which are gas to be humidified can determine the value of the temperature to raise. the temperature of the oxygen enrichment gas obtained with the oxygen enricher by the PSA method -- outside air temperature -- abundance -- it is high. Usually, the range of 1-2 \*\* is almost the case. Supposing it is higher than the open air 2 \*\* now, in order to raise this to 90% of relative humidity, it will be influenced very much by the permeation performance of a moisture transmission film, but it is necessary to raise temperature to not less than about 5-16 \*\*, and to maintain a primary side to a high moisture partial pressure in the permeation performance in the present technological level.

[0020]Then, in the compressed air supply means which takes in and compresses the atmosphere containing a steam, and the humidification means which comprises the membrane module which uses a hollow filament transmission film as barrier membrane, The compressed air compressed into one barrier membrane side of this humidification means by the compressed air supply means Through, It constitutes so that it may let gas to be humidified pass to the another side side of barrier membrane, and temperature of the course which the compressed air from a compressed air supply means, a humidification means, and a compressed air supply means to a humidification means passes is considered as the composition which beyond constant value raises from atmospheric temperature.

[0021]In order to maintain to the temperature concerned, the heat generated within the oxygen enricher by the PSA method is efficiently used for this invention. This is performed by accommodating the humidification means by the membrane module concerned in the inside of the case which accommodates a compressed air supply means including an electric motor and the exothermic equipment which consumes electrical energy in addition to this. This case is good to use a sound insulation construction and to serve also as the effect which prevents a break through of noise, such as an electric motor which is also apparatus which generates noise and/or an air supply means, and a fan means. However, in the apparatus which does not need noise control, it is not necessary to use a noise control case. In the outside passage 5 and inner passage of the hollow filament transmission film 4 in a membrane module (humidification means 3). Although ventilation resistance has little one where a cross-section area is larger and it is easy to pass compressed air, since the direction which makes the cross-section area of an outside passage large can create a membrane module, without increasing the number of a hollow

filament, The direction passed to the outside passage 5 has little ventilation resistance, and can supply compressed air to an adsorption column efficiently, since the compressed air containing moisture and the exhaust gas can make so low the air pressure generated in a compressed air supply means, the load of an electric motor also becomes light and they can also reduce power consumption.

[0022]The compressed air which contains many moisture by constituting in this way passes, and an outside passage in an inner passage. Since concentration generation is carried out, and moisture is hardly contained, but the low-pressure oxygen enrichment gas by which pressure regulation was carried out with the reducing valve 10 passes and only the moisture in the atmosphere penetrates toward the inside from the outside, The moisture obtained by separating out of the atmosphere will be given to the condensed oxygen enrichment gas, and will be humidified, a supplement and clearing work of moisture like the humidifier of a cellular formula used from the former become unnecessary, and, thereby, an insanitary cause can be abolished.

[0023]

[Working example]Hereafter, although Drawings explain concretely especially the composition about the desirable embodiment of this invention centering on the humidification means 3, of course, this is a thing for explanation, and this invention is not limited to these embodiments.

[0024]The embodiment shown in drawing 1 is an example constituted so that the whole quantity of the compressed air pressurized by the compressed air supply means 2 might be passed to the outside passage 5 of the humidification means 3 using the hollow filament transmission film 4. The moisture contained while passing through the outside passage 5 penetrates to the inner passage of a hollow filament, separation removal is carried out to it, and compressed air is supplied to the adsorption column 12 or the entrance end of 13 via the valve means 11 which controls operation of the PSA method. And in an adsorption column, adsorption treatment of the nitrogen etc. is carried out, they generate oxygen gas, and this oxygen enrichment gas is stored by the buffer tank 16. The oxygen enrichment gas stored by the buffer tank 16 is adjusted so that the reducing valve 10 and the throttle valve 9 may make a proper pressure and a flow, it is supplied to the inner passage of the hollow filament transmission film 4 of the humidification means 3, and the aforementioned moisture by which separation removal was carried out from compressed air is given and humidified, and it is supplied to a patient from the output port 8.

[0025]Here, the suction filter 1 is for removing the dust in the air and supplying pure air to the compressed air supply means 2. Adjust the reducing valve 10 to a suitable pressure (for example, about  $0.3\text{kgf}/\text{cm}^2\text{-G}$ ) to present use with the oxygen gas currently stored in the buffer tank 16, and the throttle valve 9, It may be whichever thing, as long as it adjusts the flow of the oxygen enrichment gas which is taken out from the output port 8 and supplied to a patient and can adjust flows of gas, such as a needle valve type and an orifice selection type. Attach the throttle valve 20 changed between the entrance side of the inner passage of the hollow filament transmission film 4 of the humidification means 3, and an outlet side, a part of oxygen enrichment gas which is not humidified is made to bypass; and what is necessary is just to mix to the humidified oxygen enrichment gas, when the degree of humidification needs to be adjusted.

[0026]Although the hollow filament transmission film used by this example was constituted from a perfluoro system ion-exchange membrane, they may be ion-exchange membranes other than this. In the figure, although the hollow filament transmission film 4 expressed from the entrance side as one double line to the outlet side, it used what made one bundle actually about 3500 hollow filaments the outer diameter of 0.3 mm, 0.15 mm in inside diameter, and about 25 cm in length.

[0027]The entrance and exit which lead to the outside of the humidification means 3 of the outside passage 5 and the inner passage of the hollow filament transmission film 4 in the humidification means 3, Although it may be whichever of the humidification means 3 and the directivity of the passage does not have a structure top, it is more desirable to constitute the flow of the compressed air containing moisture, and the flow of dry oxygen enrichment gas so that it may become a direction which counters mutually. The rate to which, as for the Reason, moisture penetrates the barrier membrane of a hollow filament, Since it is proportional to the

partial pressure difference of the moisture in the gas instead of the pressure differential of both gases as mentioned above. By making mutual for reverse the compressed air to which the moisture to contain is removed and the partial pressure of moisture falls gradually, and its flowing direction of the oxygen enrichment gas with which it is humidified and the partial pressure of moisture rises gradually. Since the partial pressure of the moisture of both gases becomes migrate to the whole region mostly and in general equal in the outside within the humidification means 3, and inside both passages, it is for heightening the humidification effect further. However, in the 2nd embodiment stated to this example or the next, since there is enough much quantity of the compressed air which flows through the outside passage 5 of a hollow filament, or exhaust gas as about 30 times as compared with the quantity of oxygen enrichment gas, so prominent an effect does not appear.

[0028]Although an embodiment shown in drawing 2 is fundamentally the same as an embodiment of aforementioned drawing 1, it is an example which constituted a part of compressed air pressurized by the compressed air supply means 2 so that it might pass to the outside passage 5 of the hollow filament transmission film 4 within the humidification means 3. Moisture contained while passing through a passage within the humidification means 3 penetrates to an inner passage of a hollow filament transmission film, separation removal is carried out to it, and compressed air is emitted via the throttle valve 20 and the silencer 21 after that in the noise control case 29 which has the aforementioned soundproof function. It is better to lessen compressed air used for humidification as much as possible, since it emits into the atmosphere, and is discarded and it becomes useless. The flow may be almost the same as a flow of oxygen enrichment gas passed to the humidification means 3. Since quantity of compressed air supplied to a direction of an adsorption column will decrease and performance as the whole oxygen enricher will fall if it becomes a flow beyond it, it adjusts so that a degree which there are few the flows and is humidified may become the optimal by the throttle valve 20. Since noise occurred if emitted to the atmosphere just behind this throttle valve 20, the silencer 21 was attached, but as long as soundproof functions are enough cases, there may not be the silencer 21.

[0029]On the other hand, the remainder which occupies the great portion of compressed air is supplied to the adsorption column 12 or 13 via the valve means 11 which controls operation of the adsorption separation by the PSA method. And in this adsorption column, adsorption treatment of the nitrogen etc. is carried out, they generate oxygen enrichment gas, and this oxygen enrichment gas is stored by the buffer tank 16. The oxygen enrichment gas stored by the buffer tank 16 is adjusted so that the reducing valve 10 and the throttle valve 9 may make a proper pressure and a flow, it is supplied to the inner passage of the hollow filament transmission film 4 of the humidification means 3, and the aforementioned moisture by which separation removal was carried out from compressed air is given and humidified, and it is supplied to a patient from the output port 8.

[0030]In this embodiment, since the quantity of the gas which flows in the outside passage and inner passage of a hollow filament was made to become almost equal, even if it passes each gas to which passage between two passages of the humidification means 3, it does not interfere. In such a case, as for the direction into which each gas flows as mentioned above, it is preferred that it is countering. (In drawing 2, it is a uniform direction on account of drawing)

[0031]Although the embodiment shown in drawing 3 is fundamentally the same as the embodiment of aforementioned drawing 1, via the valve means 11, the compressed air from the compressed air supply means 2 is supplied to the adsorption column 12 or 13, is condensed, oxygen enrichment gas is generated, and this oxygen enrichment gas is stored by the buffer tank 16. And when the adsorption column 12 or 13 goes into a decompression desorption process, the part is made to flow backwards to an adsorption column through the orifice 14, desorption of the nitrogen etc. which were adsorbed is helped, and the exhaust gas desorbed here is introduced into the outside passage 5 of the hollow filament of the humidification means 3 via the valve means 11. The exhaust gas which separation removal of the moisture contained in exhaust gas was penetrated and carried out to the inner passage of the hollow filament, passed through the inside of a membrane module, and was dried is emitted via the silencer 17 in the noise control

case 29 which has the aforementioned soundproof function. On the other hand, the aforementioned oxygen enrichment gas was supplied to the inner passage of the hollow filament in \*\*\*\* 3, and it constituted so that the moisture by which separation removal was carried out from exhaust gas might be given and humidified.

[0032]In this case, since the humidification means which made ventilation resistance when the pressure at the time of the decompression desorption process of an adsorption column needed to be low lowered as much as possible within predetermined time and the exhaust gas at the time of desorption flowed as low as possible is needed, Like the case of the embodiment of said drawing 1, the inner passage of the hollow filament was made into the passage of oxygen enrichment gas, and the outside passage 5 was made into the passage of exhaust gas. Although relative humidity is higher than the inside of the atmosphere, since a pressure is low since it is opening wide and decompressing to the atmosphere, and the partial pressure difference of the moisture of both the gases produced within and without the hollow filament transmission film 4 is comparatively low, the humidification effect also falls a little rather than the embodiment of said drawing 1, but the exhaust gas at the time of desorption. 50 to 90% (RH) It is and is completely satisfactory practically. When the degree of humidification needs to be adjusted also at this example, It is the same as the embodiment of said drawing 1 that what is necessary is just to mix to the oxygen enrichment gas which attached the throttle valve changed between the entrance side of the inner passage of the hollow filament transmission film 4 of the humidification means 3 and an outlet side, made bypass a part of oxygen enrichment gas which is not humidified, and was humidified.

[0033]Mounting into a case in an embodiment shown in drawing 1 – drawing 3 is performed by a method similar to a method shown in drawing 4 and drawing 5, accommodates a humidification means by a membrane module in a case which makes a heat source a rise in heat by an internal exothermic equipment, and enables it to maintain a moisture partial pressure of a primary side highly. This also serves also as a prevention case which prevents noise from a noise source.

[0034]

[Effect of the Invention]The cellular type humidifier used from the former by using the oxygen enricher of this invention, It is released from the troublesome work of a supplement of water, exchange, cleaning of a container, etc., etc., and since the lid of a humidifier is imperfect, the situation said that oxygen gas leaks can also be prevented, and also the worries and the measure against a sound with which air bubbles burst also become unnecessary. Not to mention the electric motor used as the noise source of equipment, a compressed air supply means, a fan means, etc., since the humidification means was also accommodated in the case with a soundproof effect and the device peculiar to the ventilation passage for cooling is moreover given, an operation sound is dramatically quiet, and it is suitable as an oxygen enricher of medical application.

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[Translation done.]

\* NOTICES \*

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- 3.In the drawings, any words are not translated.

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DESCRIPTION OF DRAWINGS

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[Brief Description of the Drawings]

[Drawing 1]It is a figure showing the flow plan of the oxygen enricher which is a suitable embodiment of this invention.

[Drawing 2]It is a figure showing the flow plan of the oxygen enricher which are other embodiments of this invention.

[Drawing 3]It is a figure showing the flow plan of the oxygen enricher which are other embodiments of this invention.

[Drawing 4]It is drawing of longitudinal section of a right half part showing typically an example of the composition inside the external case of an oxygen enricher.

[Drawing 5]It is a figure for explaining the composition inside the case which has a soundproof function.

[Explanations of letters or numerals]

1 Suction filter

2 Compressed air supply means

3 Humidification means

4 Hollow filament transmission film

5 Outside passage

8 Output port

9, 20 throttle valves

10 Reducing valve

11 Valve means

12 and 13 Adsorption column

14 Orifice

16 Buffer tank

17 and 21 Silencer

23 External case

24 Air intake

25 Air air supply port

26 Air inlet door

27 Airstream exit

28 Air outlet

29 and 30 Noise control case

31 Fan means

32 Communicating opening part

33 Sound insulating board

34 Atmospheric-streams ON passage

35 Atmospheric exhaust passage

36 The duct for silence

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[Translation done.]

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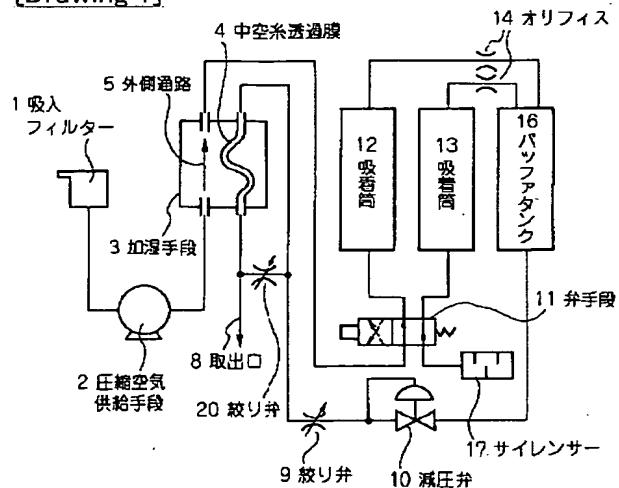
2.\*\*\*\* shows the word which can not be translated.

3.In the drawings, any words are not translated.

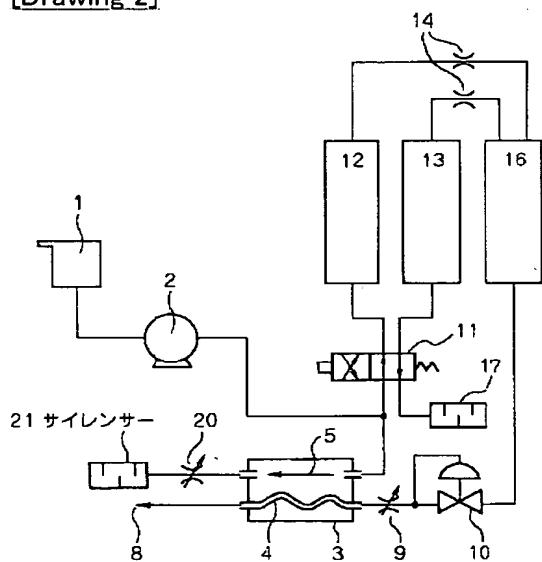
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DRAWINGS

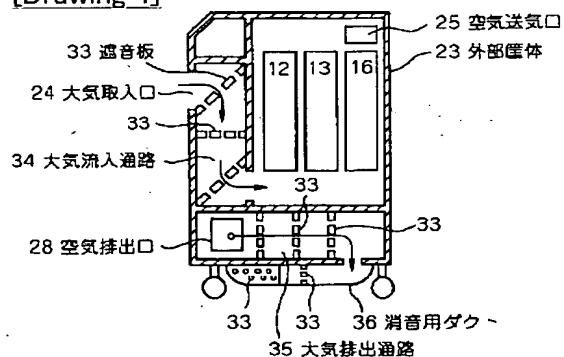
[Drawing 1]



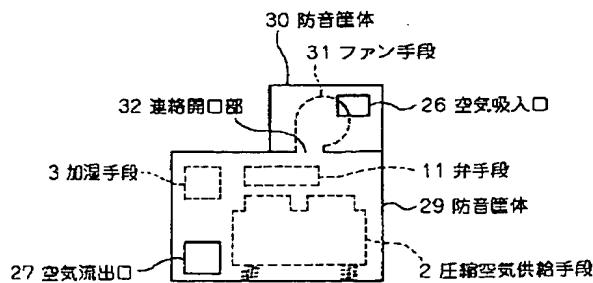
[Drawing 2]



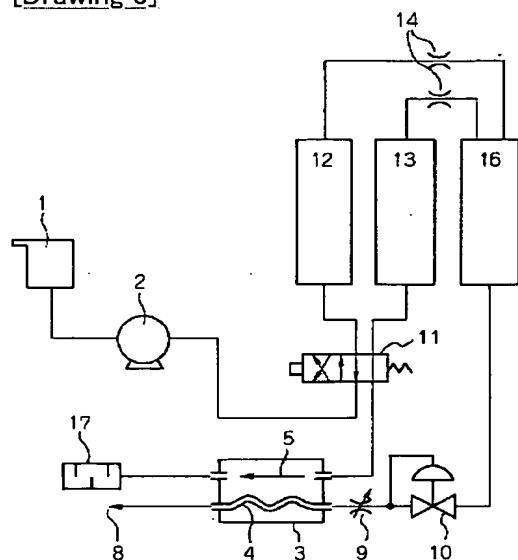
[Drawing 4]



[Drawing 5]



[Drawing 3]




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[Translation done.]

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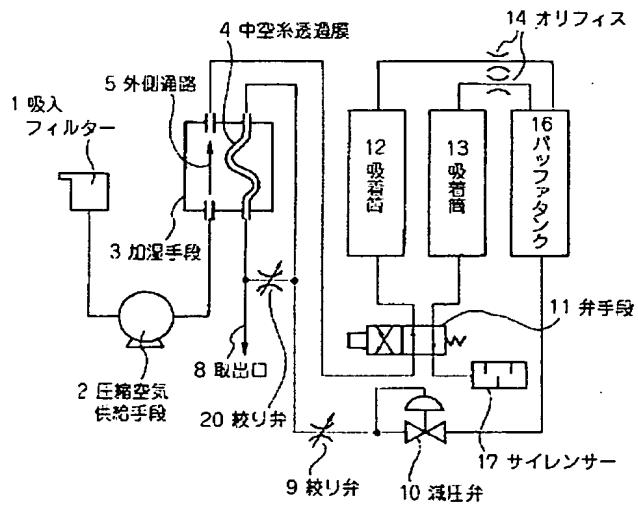
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## (54)【発明の名称】 医療用の酸素濃縮器

## (57)【要約】

【構成】 壓力変動吸着法 (PSA法)による酸素濃縮器に、水分透過可能な中空糸透過膜を隔膜とする膜モジュールを加湿手段3として付設し、圧縮空気、もしくは吸着筒の減圧脱着工程時に脱着し排出される排気ガスを膜モジュールに供給して、含有する水分を中空糸透過膜により分離除去し、吸着筒12、13で濃縮された酸素富化ガスにその水分を与えて加湿するように構成した。また、加湿手段は、運転時には周囲温度より高温となる電動機、圧縮空気供給手段2、ファン手段等の熱発生源や騒音源となる機器類と共に、防音機能を有する筐体内に収容した。

【効果】 従来の気泡式加湿器の、水の補充や交換、容器の清掃とうの煩わしい作業から解放され、また、加湿器の蓋が不完全なために酸素ガスが漏れると言う事態も防止できる他、気泡のはじける音の心配や対策も不要になり、外気温度が低温となり相対湿度が低下する季節であっても、適正な加湿効果が得られる。



## 【特許請求の範囲】

【請求項1】 吸着剤を充填した少なくとも1個の吸着筒、該吸着筒に圧縮空気を供給するための電動機の動力で駆動される圧縮空気供給手段、該電動機及び／又は圧縮空気供給手段を冷却するためのファン手段とで基本的に構成された圧力変動吸着法（P.S.A法）による酸素濃縮器において、水分透過可能な中空糸透過膜を隔膜とする膜モジュールを加湿手段として付設し、前記圧縮空気供給手段からの圧縮空気、もしくは吸着筒の減圧脱着工程時に脱着し排出される排気ガスを膜モジュールの隔膜の一方の側に供給して、該圧縮空気もしくは排気ガス中に含有する水分を中空糸透過膜により分離除去し、中空糸透過膜により分離された水分を、前記吸着筒にて濃縮され該膜モジュールの他方の側に供給された酸素富化ガスに与えて加湿するように構成すると共に、該膜モジュールによる加湿手段は、前記の電動機及び／又は圧縮空気供給手段、ファン手段等の動作時には騒音を発生する機器類と共に、防音機能を有する筐体内に収容したことを特徴とする医療用の酸素濃縮器。

【請求項2】 吸着剤を充填した少なくとも1個の吸着筒、該吸着筒に圧縮空気を供給するための電動機の動力で駆動される圧縮空気供給手段、該電動機及び／又は圧縮空気供給手段を冷却するためのファン手段とで基本的に構成された圧力変動吸着法（P.S.A法）による酸素濃縮器において、水分透過可能な中空糸透過膜を隔膜とする膜モジュールを加湿手段として付設し、前記圧縮空気供給手段からの圧縮空気、もしくは吸着筒の減圧脱着工程時に脱着し排出される排気ガスを膜モジュールの隔膜の一方の側に供給して、該圧縮空気もしくは排気ガス中に含有する水分を中空糸透过膜により分離除去し、中空糸透过膜により分離された水分を、前記吸着筒にて濃縮され該膜モジュールの他方の側に供給された酸素富化ガスに与えて加湿するように構成すると共に、前記の圧縮空気供給手段、膜モジュールによる加湿手段、及び圧縮空気供給手段から加湿手段までの圧縮空気の通過する通路を、外気温度より一定値以上高い温度に保つように構成したことを特徴とする医療用の酸素濃縮器。

【請求項3】 圧縮空気供給手段、膜モジュールによる加湿手段、及び圧縮空気供給手段から加湿手段までの圧縮空気の通過する通路を、前記の電動機及び／又は圧縮空気供給手段等の動作時に熱を発生する機器類を収納して、外気より温度が高められる筐体内に収容したことを特徴とする、請求項2記載の医療用酸素濃縮器。

【請求項4】 電動機及び／又は圧縮空気供給手段等の動作時に熱を発生する機器類を収納した筐体が、防音機能を有するものであることを特徴とする、請求項3記載の医療用酸素濃縮器。

【請求項5】 圧縮空気供給手段からの圧縮空気を、加湿手段となる膜モジュール内の中空糸の外側通路に供給して、該圧縮空気中に含有する水分を中空糸の内側通路

へ透過させて分離除去し、膜モジュール内を通過した圧縮空気は前記吸着筒へ供給し濃縮して、酸素富化ガスを発生させ、続いて該酸素富化ガスを膜モジュール内の中空糸の内側通路に供給し、圧縮空気から分離除去された水分を与えて加湿するように構成したことを特徴とする、請求項1乃至請求項4のいずれかに記載の医療用の酸素濃縮器。

【請求項6】 圧縮空気供給手段からの圧縮空気の一部を、加湿手段となる膜モジュール内の中空糸の外側もしくは内側の通路に供給して、該圧縮空気中に含有する水分を中空糸の他方側通路へ透過させて分離除去し、膜モジュール内を通過した圧縮空気は、絞り弁を介して前記防音機能を有する筐体内に放出させ、一方、圧縮空気の残部は前記吸着筒へ供給し濃縮して、酸素富化ガスを発生させ、続いて該酸素富化ガスを膜モジュール内の中空糸の前記他方側通路に供給し、圧縮空気から分離除去された水分を与えて加湿するように構成したことを特徴とする、請求項1乃至請求項4のいずれかに記載の医療用の酸素濃縮器。

【請求項7】 圧縮空気供給手段からの圧縮空気を吸着筒へ供給し濃縮して、酸素富化ガスを発生させ、該吸着筒の減圧脱着工程時に脱着し排出される排気ガスを、加湿手段となる膜モジュール内の中空糸の外側通路に供給して、該排気ガス中に含有する水分を中空糸の内側通路へ透過させて分離除去し、膜モジュール内を通過した排気ガスは、絞り弁を介して前記防音機能を有する筐体内に放出させ、一方、前記の酸素富化ガスを膜モジュール内の中空糸の内側通路に供給し、排気ガスから分離除去された水分を与えて加湿するように構成したことを特徴とする、請求項1乃至請求項4のいずれかに記載の医療用酸素濃縮器。

## 【発明の詳細な説明】

## 【0001】

【産業上の利用分野】本発明は、呼吸不全患者（以下、単に患者ともいう）が主として在宅酸素療法に使用する医療用の酸素濃縮器に関するもので、なかでも圧力変動吸着法（以下、P.S.A法ともいう）によって濃縮された酸素ガス（酸素富化ガスを含む、以下同じ）の新規な構成の加湿手段に関するものである。

## 【0002】

【従来の技術】医療用の酸素濃縮器は、主に前記の患者が在宅酸素療法に使用する酸素ガスの供給源として用いるものである。このため酸素濃縮器に対しては、種々の条件が要求され、その内容としては次のような事柄が挙げられる。

医療用に使用するのであるから、信頼性が高いこと。長期にわたって昼夜を問わず連続的に使用することが多いので、患者本人は勿論、同居や同室の家族の人々も含めて安眠を妨げることがないよう、騒音の少ない静かな装置であること。

P S A 法による酸素濃縮器から吐出する酸素ガスは、水分がほぼ完全に除去された非常に乾燥したガスであるので、これをそのまま患者が呼吸用として使用すると、鼻腔粘膜や気道が乾き苦痛を伴うので、該酸素ガスを加湿する機能を有すること。

家庭用の電源を使用するために、消費電力の少ないこと。

【0003】第項の酸素ガスの加湿については、多くの場合、酸素ガスを水の入った容器の中を気泡の形でぐらせて加湿した後に、呼吸用として吸入している。しかしながら、患者にとっては、酸素濃縮器から出てくる酸素ガスを加湿するためには、多くの手間がかかり煩わしいため、加湿器への水の補充や交換、容器の清掃作業等から解放されたいという強い要望がある。

【0004】従来から多く使用されている加湿器には、次のような問題点がある。

加湿器内の水は、使用するにつれて蒸発消耗するので補給する必要があり、また、この加湿器の容器内に雑菌や藻類が繁殖したり、ゴミ等の付着による汚れがあつたりするので、おおむね1週間に1回程度の清掃が必要となる。

加湿器の清掃や水の補充・交換時には、加湿器の蓋を十分に、かつ確実に締めないと酸素ガスが漏れて患者の方へ行かないという不具合が生じる。

酸素濃縮器や加湿器を使用する患者は、体力も比較的弱く、また、高齢者が多いため、加湿器の蓋が十分確実に締まらないことがあり、この問題は切実、かつ重大な事柄である。

【0005】この加湿器は、酸素濃縮器の外殻を構成する筐体から外部に向かって凸状に出張って取付けられるものと、筐体に凹状のくぼみ部を設けてこの凹部の中に取付けるものとがあるが、前者の凸状に取付けるものは、人が装置の近くを歩くとき、誤ってぶつかったりして加湿器の取付部（主に酸素ガスの供給口を兼ねるものが多い）を折損する事故がある。また、後者の凹部の中に取付けるものは、ゴミ等が集積し易く、医療用機械を不衛生にすることになる。このため、凹部の前に扉を付設してゴミ等が入りにくくする方法もあるが、扉が破損したり、水の補充や交換時に煩わしいという問題もある。

【0006】在宅酸素療法に使用する酸素濃縮器は、昼夜を問わずに使用するために、周囲の暗騒音が比較的多い昼間にはそれほど気にならなかった、前記の加湿器の気泡から生ずる音が、周囲が静になる夜間には騒音として耳につき、患者の中にはこの騒音のために安眠を妨げられている者もある。このために、前述の如く酸素濃縮器の筐体の凹部に加湿器を収容し、その前面に扉を付設してゴミ等の侵入を防ぐとともに、この騒音の低減効果を期待したものもある。

【0007】

【発明が解決しようとする課題】このような従来の加湿器で生じる種々の問題点を解決し、水の補充や交換を必要とせず、かつ動作音のより小さい静粛な医療用の酸素濃縮器を提供することを目的とする。

【0008】

【課題を解決するための手段】即ち本発明は、吸着剤を充填した少なくとも1個の吸着筒、該吸着筒に圧縮空気を供給するための電動機の動力で駆動される圧縮空気供給手段、該電動機及び／又は圧縮空気供給手段を冷却するためのファン手段とで基本的に構成された圧力変動吸着法（P S A 法）による酸素濃縮器において、水分透過可能な中空糸透過膜を隔壁とする膜モジュールに供給して、該圧縮空気中に含有する水分を中空糸透過膜により分離除去し、圧縮空気から分離された水分を、前記吸着筒にて濃縮され加湿手段に供給された酸素富化ガスに与えて加湿するように構成すると共に、該膜モジュールによる加湿手段は、前記の電動機及び／又は圧縮空気供給手段、ファン手段等の動作時に騒音を発生する機器類と共に、防音機能を有する筐体内に収容したことを特徴とする医療用の酸素濃縮器である。さらに、前記の圧縮空気供給手段、膜モジュールによる加湿手段、及び圧縮空気供給手段から加湿手段までの圧縮空気の通過する通路を、外気温度より一定値以上高い温度に保つように構成したことを第2の特徴とし、そして各手段を、前記の電動機及び／又は圧縮空気供給手段等の動作時に熱を発生する機器類と共に、筐体内に収容することにより、外気温度より高い温度の保持を図っている。

【0009】以下、図面に基づいて本発明を詳細に説明する。図1～図3は本発明の好適な実施例となる酸素濃縮器のフローシートで、図4は酸素濃縮器の外部筐体内部の構成の一例を模式的に示した図（右半部の縦断面図）、また図5は防音機能を有する筐体（外部筐体の左半部に収容）内部の構成を説明するための図である。

【0010】P S A 法による酸素濃縮器は、電動機の動力で駆動される圧縮空気供給手段2、吸着剤を充填した1個もしくは複数個の吸着筒12、13、及び電動機及び／又は圧縮空気供給手段2を冷却するためのファン手段31で基本的に構成され、これに必要に応じて、吸着筒12、13で発生した酸素富化ガスを貯留するためのバッファタンク16、酸素富化ガスに水分を与えて加湿するための加湿手段3を加えた構成となっている。

【0011】そして、吸入フィルター1から取り入れられた空気は、まず圧縮空気供給手段2で加圧圧縮され、例えば吸着筒が2個の場合は、P S A 法の操作を制御する弁手段11により2個の吸着筒12、13に交互に供給される。吸着筒では窒素等が吸着除去されて酸素ガスを発生し（加圧吸着工程）、この酸素富化ガスはバッファタンク16に貯留され、その一部はオリフィス14を通して、加圧吸着工程を終了し減圧排気中の吸着筒に逆流させ、吸着された窒素等の脱着を助けて吸着剤の再生

を行ない（減圧脱着工程）、その排気ガスはサイレンサー17を介して大気中に排出される。バッファタンク16に貯留された酸素富化ガスは、減圧弁10と絞り弁9で適宜の圧力、流量になるように調整して、患者に供給される。

【0012】これらの各装置は外部筐体23の中に収納されているのであるが、動作時には騒音が多いいため、外部筐体23の外殻を防音材で構成して遮音性を持たせる他、例えば図4に示すように、電動機や圧縮空気供給手段2等を冷却するための、大気流入通路34や大気排出通路35に遮音板33を設け、あるいは外部筐体23の底部に消音用ダクト36を設けるなど、騒音を低下させるためにさまざまな工夫が為されている。

【0013】そしてさらに防音機能を高めるため、動作時に騒音の発生源となる電動機を含む圧縮空気供給手段2、ファン手段31、圧縮空気や排気ガス、酸素富化ガス等の流れをコントロールする弁手段11などは、図5に示すような、外部筐体23内の防音機能を有する防音筐体29、30内に収容して二重構造にするのが良い。尚、大気取入口24から取り入れられた空気は、大気流入通路34を通り空気送気口25を経て、空気吸入口26から防音筐体30に入り、さらにファン手段31により連絡開口部32から防音筐体29に入り、その一部は原料空気として圧縮空気供給手段2に取り込まれ、大部分は電動機を含む圧縮空気供給手段やその他電気エネルギーを消費する発熱機器類を冷却し、熱交換して暖められた温風は空気流出口27から空気排出口28、消音用ダクト36を経て大気中に排出される。しかし、筐体内部の温度は外気温度に対して高くなるが、通常その外気温より高くなる温度は30°C以下、適正には20°C程度になるように冷却手段が構成され、膜モジュールによる加湿手段もこの温度の筐体内に収容する。図5の例では、2つの防音筐体29、30を結合して用いたが、ファン手段31も防音筐体内部に収容して、1個の防音筐体で構成してもよい。

【0014】また、消音用ダクト36は、外部筐体23の底面下に取付けられたキャスターが作る、外部筐体と大地又は床面との間の空間を有効に活用したもので、外部筐体23の底面に接して遮音材で構成され、かつ、その大気通路内面には吸音材を貼付けし、遮音板も付設してある。本発明で用いた遮音板は、遮音材の両面又は片面に吸音材を貼付け、その面内に複数個の貫通孔を明けたもので、音波を吸収しながら冷却風を通すという作用があるが、これに限定する必要はなく他の態様のものであってもよいことは勿論である。

【0015】また、バッファタンク16から減圧調整して患者に供給される酸素富化ガスは、水分がほぼ完全に除去され乾燥した状態になっているので、通常は減圧弁10の後に、気体を水中にくぐらせて水分を与える気泡式等の加湿器を設けるが、その気泡のはじける音でさえ

も低騒音化の対象となっている。本発明では、従来の気泡式加湿器の代わりに、中空糸透過膜を用いた加湿手段3を使用するが、同様に騒音をより小さくするため、及び後述する理由により、外気より温度の高い防音筐体29内に収容する。

【0016】本発明における課題を解決するための手段として使用する、中空糸透過膜を隔膜とする膜モジュールを用いた加湿器3について、さらに詳細に説明する。

#### 【0017】

【作用】膜モジュールを構成する中空糸透過膜は、大気中の水分を最も良く透過するもので、その透過率は中空糸透過膜の外側と内側との大気中の水分の分圧差に比例する。中空糸透過膜壁を隔てて、外側を水分を含む加湿空気の通る一次側、内側を乾いた酸素富化ガスの通る二次側とすると、水分分圧は一次側が高く、二次側が低い。水分透過の原理は、一次側より水分分子が透過膜の膜壁中を拡散移動し、二次側壁面より放散することにより水分分子が膜壁を透過する。パーフルオロイオン交換膜による透過膜の単位面積当たりの水分透過量はかなり多いので、一次側、二次側の分圧差が少なくても効率の良い透過が得られる。また二次側を高い湿度に加湿するためには一次側の水分分圧を高くする必要がある。

【0018】大気に含まれる水分を用いて乾いた酸素富化ガスを加湿するのであるから、水分供給の一次側の水分分圧は大気中に含まれる水分量、すなわち外気の温度とその相対湿度に左右され、温度が低く相対湿度が低いと二次側を十分に加湿できないことも生ずる。日本に於ける北海道から沖縄に至る主要都市の一年の月別平均相対湿度は、ほとんどが60~90%に分布している。そして湿度の低い季節は3月・4月であり、また緑の少ない東京等、都市の相対湿度は低い。また、一年を通した月別平均気温は-9~29°Cの広い範囲に分布しており、北海道など冬期は室内暖房により乾燥し、相対湿度は相当低くなる。0°Cで80%の相対湿度の大気中に含まれる水分分圧は4.89ミリバールである。これを4kgf/cm<sup>2</sup>Gに加圧すると容積が1/5となり、水分分圧は5倍の24.45ミリバールになる。この温度の低い状態での実験では、二次側に透過して出る水分では、加湿されるべき酸素富化ガスの相対湿度が計算による目標値に達しないことが時々生じた。銳意研究の結果、一次側の加湿空気が加湿手段に至るまでの経路で冷やされて温度が低くなるため結露し、二次側ガスを加湿するのに必要な十分なガスの水分分圧が得られない事があることが判った。

【0019】従って、この例で示す一次側水分分圧の24.45ミリバールを維持するには、22°C以上に加温しなければ空気中の水分が結露し、その温度の飽和水蒸気圧以上にはならない。このため一次側の水分分圧を高めるためには空気を加圧するばかりでなく、その温度を取り入れる外気より高い温度にしておかなければ、高い

水分分圧を維持できない。その高める温度の値は、被加湿ガスである二次側ガスの温度と目標加湿値により決定できる。P S A法による酸素濃縮器で得られる酸素富化ガスの温度は、外気温より数度高い。通常1~2°Cの範囲がほとんどである。いま外気より2°C高いとすると、これを相対湿度90%まで高めるためには、水分透過膜の透過性能にも大変影響されるが、現行の技術レベルでの透過性能では温度を約5~16°C以上に高めて一次側を高い水分分圧に維持する必要がある。

【0020】そこで、水蒸気を含む大気を取り入れて圧縮する圧縮空気供給手段と、中空糸透過膜を隔膜とする膜モジュールから成る加湿手段において、該加湿手段の隔膜の一方の側に圧縮空気供給手段で圧縮した圧縮空気を通し、隔膜の他方の側に被加湿ガスを通すように構成し、圧縮空気供給手段と加湿手段、及び圧縮空気供給手段から加湿手段までの圧縮空気の通過する経路の温度を、大気温度より一定値以上高めておく構成とする。

【0021】本発明は、当該温度に維持するために、P S A法による酸素濃縮器内で発生する熱を効率良く使用するものである。これは電動機を含む圧縮空気供給手段やその他電気エネルギーを消費する発熱機器類を収容する筐体内部に、当該膜モジュールによる加湿手段を収容することにより行う。尚、この筐体は防音構造にして、騒音を発生する機器でもある電動機及び／又は空気供給手段、ファン手段等の騒音の漏出を防ぐ効果をも兼ねるものとするのが良い。但し、防音を必要としない機器においては、防音筐体を用いる必要はない。また、膜モジュール（加湿手段3）内の、中空糸透過膜4の外側通路5と内側通路とでは、断面積の広い方が通気抵抗が少なく、圧縮空気を流し易いが、膜モジュールは外側通路の断面積を広くする方が、中空糸の本数を増やすことなく作成できるので、水分を含有する圧縮空気や排気ガスは外側通路5に流す方が通気抵抗が少なく、吸着筒に圧縮空気を効率良く供給でき、圧縮空気供給手段で発生する空気圧力をそれだけ低くできるので電動機の負荷も軽くなり消費電力も低減出来る。

【0022】このように構成することにより、水分を多く含有する圧縮空気が外側通路を通過し、内側通路には、濃縮生成された水分をほとんど含有せず、減圧弁10で圧力調整された低圧の酸素富化ガスが通過し、外側から内側に向かって大気中の水分のみが透過するので、大気中から分離して得た水分を、濃縮された酸素富化ガスに与えて加湿することになり、従来から用いられている気泡式の加湿器のような水分の補充や交換作業が不要となり、これにより不衛生の原因を無くすことが出来る。

【0023】

【実施例】以下、図面により本発明の好ましい実施例について、特に、加湿手段3を中心とした構成について具体的に説明するが、むろんこれは説明のためのものであって、本発明はこれらの実施例に限定されるものではない。

い。

【0024】図1に示した実施例は、圧縮空気供給手段2によって加圧された圧縮空気の全量を、中空糸透過膜4を用いた加湿手段3の外側通路5に流すように構成した例である。圧縮空気は、外側通路5を通過する間に含有する水分が中空糸の内側通路へ透過して分離除去され、P S A法の操作を制御する弁手段11を介して、吸着筒12又は13の入口端に供給される。そして、吸着筒では窒素等が吸着除去されて酸素ガスを発生し、この酸素富化ガスはバッファタンク16に貯留される。バッファタンク16に貯留された酸素富化ガスは、減圧弁10と絞り弁9で適宜の圧力、流量になるように調整して、加湿手段3の中空糸透過膜4の内側通路に供給され、圧縮空気から分離除去された前記の水分が与えられて加湿され、取出口8から患者に供給される。

【0025】ここで、吸入フィルター1は、空気中の塵埃を除去して、圧縮空気供給手段2に清浄な空気を供給するためのものである。また、減圧弁10は、バッファタンク16に貯留している酸素ガスを使用に供するのに適当な圧力（例えば、約0.3kgf/cm<sup>2</sup>・G）に調整するもので、絞り弁9は、取出口8から取り出し患者に供給する酸素富化ガスの流量を調整するものであって、ニードルバルブ式やオリフィス選択型等の、ガスの流量を調節出来るものであればいずれのものであってもよい。加湿の度合を調節する必要がある場合には、加湿手段3の中空糸透過膜4の内側通路の入口側と出口側との間に可変できる絞り弁20を付設し、加湿されていない酸素富化ガスの一部をバイパスさせて、加湿された酸素富化ガスに混合すれば良い。

【0026】本実施例で使用した中空糸透過膜は、パーカルオロ系イオン交換膜で構成したが、これ以外のイオン交換膜であってもよい。また、図中では中空糸透過膜4は入口側からで出口側まで1本の2重線として表わしているが、實際には外径0.3mm、内径0.15mm、長さ約25cmの中空糸約3500本を1束としたものを使用した。

【0027】また、加湿手段3において、外側通路5及び中空糸透過膜4の内側通路の、加湿手段3の外側に通じる入口と出口は、加湿手段3のどちら側であっても良く、構造上はその通路の方向性はないが、水分を含有する圧縮空気の流れと、乾燥した酸素富化ガスの流れとは、互いに対向する方向となるように構成する方が好ましい。その理由は、中空糸の隔膜を水分が透過する率は、前述のように両気体の圧力差ではなく、その気体中の水分の分圧差に比例するため、含有する水分が除かれて徐々に水分の分圧が低下する圧縮空気と、加湿されて徐々に水分の分圧が上昇する酸素富化ガスの、その流れの方向を互いに逆向きにすることにより、加湿手段3内の外側、内側両通路のほぼ全域にわたって、両気体の水分の分圧がおおむね等しくなるので、加湿効果をいつそ

う高められるためである。但し、本実施例や次に述べる第2の実施例では、中空糸の外側通路5を流れる圧縮空気や排気ガスの量は、酸素富化ガスの量に比較して約30倍と十分多いので、それ程顕著な効果は表われない。

【0028】図2に示した実施例は、基本的には前記の図1の実施例と同じであるが、圧縮空気供給手段2によって加圧された圧縮空気の一部を、加湿手段3内の中空糸透過膜4の外側通路5に流すように構成した例である。圧縮空気は、加湿手段3内の通路を通過する間に含有する水分が中空糸透過膜の内側通路へ透過して分離除去され、その後、絞り弁20、サイレンサー21を介して、前記の防音機能を有する防音筐体29内に放出される。加湿に使用された圧縮空気は、大気中に放出して廃棄され無駄になるので、出来るだけ少なくした方が良い。その流量は加湿手段3へ流す酸素富化ガスの流量とほぼ同じで良い。また、それ以上の流量になると、吸着筒の方へ供給する圧縮空気の量が少なくなり、酸素濃縮器全体としての性能が低下するので、絞り弁20でその流量が少なく、加湿される度合いが最適となるように調節する。さらに、この絞り弁20の直後に大気に放出するのでは騒音が発生するので、サイレンサー21を付設したが、防音機能が十分な筐体であれば、サイレンサー21は無くてもよい。

【0029】一方、圧縮空気の大部分を占める残部は、PSA法による吸着分離の操作を制御する弁手段11を介して、吸着筒12又は13へ供給される。そして、この吸着筒では窒素等が吸着除去されて酸素富化ガスを発生し、この酸素富化ガスはバッファタンク16に貯留される。バッファタンク16に貯留された酸素富化ガスは、減圧弁10と絞り弁9で適宜の圧力、流量になるよう調整して、加湿手段3の中空糸透過膜4の内側通路に供給され、圧縮空気から分離除去された前記の水分が与えられて加湿され、取出口8から患者に供給される。

【0030】この実施例では、中空糸の外側通路と内側通路で流れる気体の量をほぼ等しくなるようにしたので、それぞれの気体は加湿手段3の2つの通路のうち、いずれの通路に流しても差し支えない。このような場合には、前述のように各々の気体の流れる方向は対向となることが好ましい。(図2では作図の都合上、同一方向となっている)

【0031】図3に示した実施例も、基本的には前記の図1の実施例と同じであるが、圧縮空気供給手段2からの圧縮空気を弁手段11を介して、吸着筒12又は13へ供給し濃縮して、酸素富化ガスを発生させ、この酸素富化ガスはバッファタンク16に貯留される。そして、吸着筒12又は13が減圧脱着工程に入った時、その一部をオリフィス14を通して吸着筒へ逆流させて、吸着された窒素等の脱着を助け、ここで脱着された排気ガスを弁手段11を介して、加湿手段3の中空糸の外側通路5に導入する。排気ガス中に含有する水分は中空糸の内

側通路へ透過して分離除去され、膜モジュール内を通過して乾燥した排気ガスは、サイレンサー17を介して、前記の防音機能を有する防音筐体29内に放出される。これに対して、前記の酸素富化ガスを湿手段3内の中空糸の内側通路に供給し、排気ガスから分離除去された水分を与えて加湿するように構成したことを特徴とする。

【0032】この場合には、吸着筒の減圧脱着工程時の圧力を、所定の時間内に極力低く下げる必要があり、脱着時の排気ガスが流れたときの通気抵抗を出来るだけ低くした加湿手段が必要となるので、前記図1の実施例の場合と同様に、中空糸の内側通路の方を酸素富化ガスの通路とし、外側通路5の方を排気ガスの通路とした。また、脱着時の排気ガスは、大気中より相対湿度は高いが、大気に開放して減圧しているために圧力が低く、中空糸透過膜4の内外で生ずる両気体の水分の分圧差が比較的低いために、加湿効果も前記図1の実施例よりは幾分低下するが、50～90% (R.H.) あり、実用上全く問題はない。さらに、本実施例でも加湿度の調節が必要な場合には、加湿手段3の中空糸透過膜4の内側通路の入口側と出口側との間に可変できる絞り弁を付設し、加湿されていない酸素富化ガスの一部をバイパスさせて、加湿された酸素富化ガスに混合すれば良いことは前記図1の実施例と同じである。

【0033】尚、図1～図3に示す実施例における筐体内への実装は、図4、図5に示す方法と類似の方法により行い、内部発熱機器類による温度上昇を熱源とする筐体内に膜モジュールによる加湿手段を収容し、一次側の水分分圧を高く維持できるようにする。またこれは騒音源からの騒音を防止する防止筐体をも兼ねるものもある。

#### 【0034】

【発明の効果】本発明の酸素濃縮器を使用することにより、従来から用いられている気泡式加湿器の、水の補充や交換、容器の清掃等の煩わしい作業から解放され、また、加湿器の蓋が不完全なために酸素ガスが漏れると言う事態も防止できる他、気泡のはじける音の心配や対策も不要になる。さらに、装置の騒音源となる電動機、圧縮空気供給手段、ファン手段等は勿論のこと、加湿手段も防音効果のある筐体内に収容し、しかも、冷却用の通風通路に独特の工夫を施しているので動作音が非常に静かであり、医療用の酸素濃縮器として好適である。

#### 【図面の簡単な説明】

【図1】本発明の好適な実施例である酸素濃縮器のフローシートを示す図である。

【図2】本発明の他の実施例である酸素濃縮器のフローシートを示す図である。

【図3】本発明の他の実施例である酸素濃縮器のフローシートを示す図である。

【図4】酸素濃縮器の外部筐体内部の構成の一例を模式的に示した、右半部の縦断面図である。

【図5】防音機能を有する筐体内部の構成を説明するための図である。

【符号の説明】

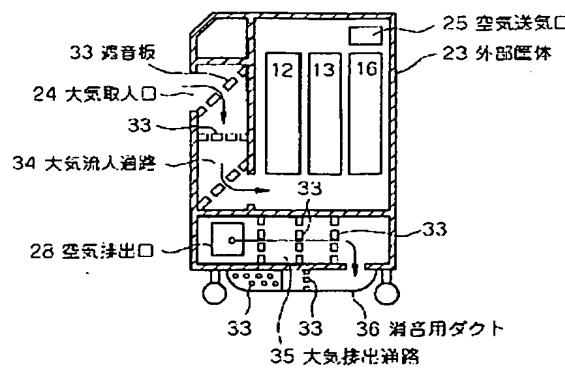
- 1 吸入フィルター
- 2 圧縮空気供給手段
- 3 加湿手段
- 4 中空糸透過膜
- 5 外側通路
- 8 取出口
- 9, 20 紋り弁
- 10 減圧弁
- 11 弁手段
- 12, 13 吸着筒
- 14 オリフィス
- 16 バッファタンク

- 17, 21 サイレンサー
- 23 外部筐体
- 24 大気取入口
- 25 空気送気口
- 26 空気吸入口
- 27 空気流出口
- 28 空気排出口
- 29, 30 防音筐体
- 31 ファン手段
- 32 連通開口部
- 33 遮音板
- 34 大気流入通路
- 35 大気排出通路
- 36 消音用ダクト

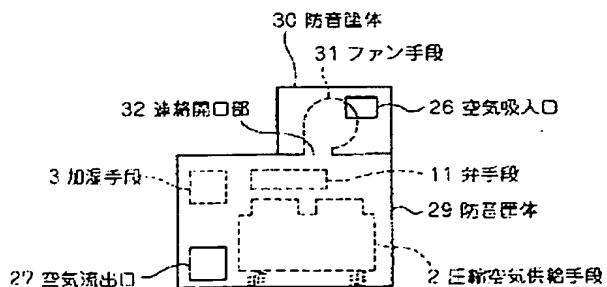
【図1】

【図2】

【図4】



【図5】



【図3】

